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(54) STEERABLE DRILLING WITH DOWNHOLE MOTOR

RICHTBOHREN MIT BOHRLOCHMOTOR

SYSTEME DE FORAGE ORIENTABLE A MOTEUR DE FOND DE PUITS

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US-A- 5 022 471

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Description

[0001] The present invention relates to a method and a system for creating a borehole in an earth formation. More specifically the invention relates to drilling of boreholes whereby a drilling assembly is applied which allows steering of a drill bit to a desired subsurface target area. A typical application in which there is a need for such steering of the drill bit, is, for example, in offshore drilling whereby a plurality of deviated wellbores are drilled from an offshore platform to multiple locations of a hydrocarbon containing zone in an earth formation. Other applications in which there is a need for steerable drilling, include drilling of horizontal or highly inclined wellbores into such a hydrocarbon containing zone.

[0002] EP-571045-A1 discloses a method of creating a borehole in an earth formation using a drilling assembly comprising a drill string extending into the borehole, a downhole motor including a housing and a drive shaft for rotating a drill bit, which drive shaft has an inclined orientation relative to a longitudinal axis of the lower part of the drill string, the motor housing being connected to the lower part of the drill string in a manner so as to allow rotation of the motor housing about said longitudinal axis, the drilling assembly further comprising control means to control rotation of the motor housing about said longitudinal axis and relative to the drill string. In the known method, a downhole motor having a housing with an adjustable bend is applied, whereby during straight drilling the bend is adjusted so that the bend angle is zero, and during curved drilling the bend is adjusted so that the bend angle corresponds to the desired borehole curvature. Prior to drilling a curved borehole section the motor housing is rotated relative to the drill string about a selected number of incremental angular steps so as to orient the motor housing in the desired azimuthal direction.

[0003] WO-A-93/23652 discloses a drilling assembly including a rotary table, a drill string, a downhole motor having a tilted output shaft and a housing connected to an output shaft of a second motor. The second motor can selectively be allowed to rotate relative to the drill string during drilling of a straight borehole section, or be locked to the drill string during drilling of a curved borehole section. Before drilling of a curved section is started the rotary table is used to align the drill string to orient the output shaft in the required direction.

[0004] It is an object of the invention to provide an improved method of creating a borehole in an earth formation whereby a downhole motor is used which allows curved drilling as well as straight drilling, without the need of a motor housing having an adjustable bend.

[0005] It is a further object of the invention to provide an improved drilling assembly for creating a borehole in an earth formation using a downhole motor which allows curved drilling as well as straight drilling, without the need of a motor housing having an adjustable bend.

[0006] In accordance with one aspect of the invention there is provided a method of creating a borehole in an earth formation using a drilling assembly comprising a drill string extending into the borehole, a downhole motor including a housing and a drive shaft for rotating a drill bit, which drive shaft has an inclined orientation relative to a longitudinal axis of the lower part of the drill string, the motor housing being connected to the lower part of the drill string in a manner so as to allow rotation of the motor housing about said longitudinal axis, the drilling assembly further comprising control means to control rotation of the motor housing about said longitudinal axis and relative to the drill string, the method comprising drilling a substantially straight section of said borehole by inducing said control means to rotate the motor housing continuously about said longitudinal axis and relative to the drill string while the downhole motor is operated to rotate the drill bit, wherein the step of drilling said substantially straight borehole section is alternated with a further step of drilling a curved section of said borehole by inducing said control means to prevent rotation of the motor housing about said longitudinal axis and relative to the drill string while the downhole motor is operated to rotate the drill bit, characterized in that prior to the step of drilling the curved section said control means is induced to rotate the motor housing about an angle corresponding to a selected orientation of the drill bit relative to the borehole.

[0007] The continuously rotating motor housing ensures that the orientation of the inclined drive shaft of the motor continuously changes so that there is no preferential direction in which the drill bit will proceed in the formation. As a consequence thereof, the drill bit will drill a straight borehole section during such continuous rotation of the housing.

[0008] In accordance with a further aspect of the invention there is provided a drilling assembly for creating a borehole in an earth formation, comprising a drill string extending into the borehole, a downhole motor including a housing and a drive shaft for rotating a drill bit, which drive shaft is oriented inclined relative to a longitudinal axis of the lower part of the drill string, the motor housing being connected to the lower part of the drill string in a manner so as to allow rotation of the motor housing about said longitudinal axis, the drilling assembly further comprising control means to control rotation of the motor housing about said longitudinal axis and relative to the drill string, means for drilling a substantially straight section of said borehole by inducing said control means to rotate the motor housing continuously about said longitudinal axis and relative to the drill string while the downhole motor is operated to rotate the drill bit, and means for alternating the step of drilling said substantially straight borehole section with a step of drilling a curved section of said borehole by inducing said control means to prevent rotation of the motor housing about said longitudinal axis and relative to the drill string while the downhole motor is operated to rotate the drill bit, characterized in that means are provided for, prior to drilling

the curved section, inducing said control means to rotate the motor housing about an angle corresponding to a selected orientation of the drill bit relative to the borehole.

[0009] The invention will be described hereinafter in more detail with reference to the accompanying drawing in which Fig. 1 shows schematically a lower part of a drilling assembly as used in the method according to the invention.

[0010] The drilling assembly shown in Fig. 1 extends into a borehole 1 formed in an earth formation 3. The assembly, of which only the lower part is shown in Fig. 1, includes a drill string in the form of a tubing 5 of relatively small diameter, for example a diameter of about 50 mm. Before being lowered into the borehole 1 the tubing 5 is stored in the form of a coil on a reel (not shown) located at surface. As drilling progresses the tubing 5 is unreeled from the reel and gradually lowered into the borehole 1. The tubing 5 is therefore also referred to as "coiled tubing", and drilling with such coiled tubing is also referred to as "coiled tubing drilling". A downhole drilling motor 6 having a housing 7 is located at the lower end of the drilling assembly, which motor 6 drives a drive shaft 8 provided with a drill bit 9 which cuts into the rock at the borehole bottom 11 during drilling. The downhole motor 6 forms a hydraulic motor of the Moineau type which is well-known in the art of steerable drilling. The drive shaft 8 and the drill bit 9 are arranged inclined relative to the motor housing 7, so that a longitudinal axis 13 of the lower end part of the coiled tubing 5 is oriented at angle 15 relative to a longitudinal axis 17 of the drive shaft 8. The longitudinal axes 13 and 17 have a point of intersection 19 located below the motor housing 7. The housing 7 of the downhole motor 6 is provided with a number of stabiliser blades 21 to stabilise and centralise the lower part of the drilling assembly in the borehole 1.

[0011] The downhole motor 6 is connected to the coiled tubing 5 via an electric motor 23 having a housing 25 and an output shaft 27, the upper end of the housing 25 being fixedly connected to the lower end of the coiled tubing 5, and the lower end of the output shaft 27 being fixedly connected to the upper end of the housing 7 of the downhole motor 6. The output shaft 27 of the electric motor 23 is rotatable about its longitudinal axis, relative to the housing 25 of the electric motor 23. When the electric motor 23 is operated the output shaft 27 rotates about its longitudinal axis, relative to the housing 25. A bore (not shown) extends through the interior of the electric motor 23, which bore provides a fluid flow path between the interior of the coiled tubing and the fluid inlet of the downhole motor 6. Thus, when drilling fluid is pumped through the coiled tubing to drive the downhole motor 6 the drilling fluid flows through the bore of the electric motor 23 to the inlet of the downhole motor 6. Electric power is provided to the electric motor 23 via a power supply line extending through the interior of a protective steel sheath 29 which is rigidly connected along the coiled tubing 5, to surface. The power supply line is connected at surface to an electric power supply (not shown) which is controlled by a suitable control system (not shown). The electric motor 23 is furthermore provided with an orientation indicator (not shown) for providing an indication of the angular orientation of the output shaft 27, and thus also of the angular orientation of the downhole motor 6, relative to the coiled tubing 5. The orientation indicator provides a signal representing said orientation of the output shaft 27 to an operator at surface, via a suitable signal line extending through the steel sheath 29.

[0012] During normal operation of the drilling assembly, a substantially straight borehole section is drilled as follows. Drilling fluid is pumped through the coiled tubing 5 and through the bore of the electric motor 23 to the fluid inlet of the downhole motor 6. Thereby the downhole motor 6 is operated to drive the drive shaft 8 and the drill bit 9. Simultaneously with operating the downhole motor 23, the control system at surface induces the power supply to provide electric power to the electric motor 23, so that the output shaft 27 of the electric motor 23 is rotated continuously at a controlled speed and thereby the housing of the downhole motor 6 is rotated at the same controlled speed. The drill bit 9 consequently rotates in the borehole 1 about both axes 13 and 17. Since the orientation of the drill bit 9 in the borehole 1 continuously changes due to the rotation of the drill bit 9 about the axis 13, there is no preferential direction for the drill bit 9 to deepen the borehole 1. Consequently the drill bit 9 drills a straight section which is substantially directed along the axis 13. It should be noted that deviations from the straight direction of the borehole section drilled in this manner, can occur if the earth formation 3 is anisotropic or inhomogeneous. However such deviations can be corrected by measuring the direction of the borehole 1 at regular intervals, for example by well-known telemetry methods, and drilling a short curved section as described hereinafter, if necessary.

[0013] When a curved borehole section is to be drilled following drilling of the straight borehole section, drilling proceeds as follows. First the control system at surface induces the power supply to operate the electric motor 23 so as to rotate the output shaft 27 about a selected angle corresponding to a selected orientation of the housing 7 of the downhole motor 6 in the borehole 1, which orientation of the motor housing 7 determines the direction in which drilling of a curved borehole section proceeds. To achieve the desired orientation of the motor housing 7, the orientation indicator is induced to provide an indication of the angular orientation of the output shaft 27 to an operator at surface. After the desired orientation is reached, the electric motor 23 is stopped, and the downhole motor 6 is operated so as to rotate the drive shaft 8 and the drill bit 9 by pumping drilling fluid through the coiled tubing 5 and through the bore of the electric motor 23 to the fluid inlet of the downhole motor 6. Thus, drilling proceeds with the housing 7 of the

downhole motor 6 stationary while the drill bit 9 rotates. Since the drill bit 9 is inclined relative to the longitudinal axis 13 of the lower part of the drilling assembly, the borehole 1 is deepened in the direction of inclination of the drill bit 9 so that a curved borehole section is drilled.

[0014] When the borehole 1 is found to be directed along the desired course, and drilling should be continued in a straight line, the electric motor 23 is operated again so as to simultaneously rotate the motor housing 7 continuously and to operate the downhole motor 6 so as to rotate the drill bit 9. To reach a target area in the earth formation 3 the drilling operator may repeat the above procedure for alternatingly drilling straight and curved borehole sections.

[0015] During drilling the coiled tubing will twist due to reaction moments acting on the coiled tubing, the degree of twist being dependent on various factors, such as the diameter and wall-thickness of the coiled tubing, the weight-on-bit, the pressure of the fluid driving the downhole motor, or the magnitude of friction forces between the coiled tubing and the borehole-wall. Instead of orienting the downhole motor by operating the electric motor in the above described manner, the motor can alternatively be oriented by varying the twist angle of the coiled tubing, for example by adjusting the weight-on-bit or by adjusting the pressure of the drilling fluid which drives the downhole motor, or by a combined operation of the electric motor and a variation of the twist angle.

[0016] Instead of applying an electric motor to rotate the housing of the downhole motor which drives the drill bit, a hydraulic motor or any other suitable motor which can be operated in a controlled manner can be applied.

[0017] Preferably said control means does not include means for controlling rotation of the motor housing about said longitudinal axis and relative to the drill string, which rotation is caused by reactive torque forces exerted to the motor housing due to the reactive torque action of the rotating drill bit in the borehole.

[0018] In conclusion, the above described method and system using a coiled tubing, a downhole motor and a second motor to control rotation of the downhole motor housing, allows drilling of straight and curved borehole sections without the need of a drill string which is rotated at surface.

Claims

1. A method of creating a borehole in an earth formation using a drilling assembly comprising a drill string (5) extending into the borehole, a downhole motor (6) including a housing (7) and a drive shaft (8) for rotating a drill bit (9), which drive shaft has an inclined orientation relative to a longitudinal axis of the lower part of the drill string, the motor housing being connected to the lower part of the drill string in a manner so as to allow rotation of the motor housing (7) about said longitudinal axis, the drilling assembly further comprising control means (23) to control rotation of the motor housing (7) about said longitudinal axis and relative to the drill string, the method comprising drilling a substantially straight section of said borehole by inducing said control means (23) to rotate the motor housing (7) continuously about said longitudinal axis and relative to the drill string while the downhole motor (6) is operated to rotate the drill bit (9), wherein the step of drilling said substantially straight borehole section is alternated with a further step of drilling a curved section of said borehole by inducing said control means (23) to prevent rotation of the motor housing (7) about said longitudinal axis and relative to the drill string while the downhole motor (6) is operated to rotate the drill bit (9), characterized in that prior to the step of drilling the curved section said control means (23) is induced to rotate the motor housing (7) about an angle corresponding to a selected orientation of the drill bit (9) relative to the borehole.

2. The method of claim 1, wherein said control means (23) does not include means for controlling rotation of the motor housing (7) about said longitudinal axis and relative to the drill string, which rotation is caused by reactive torque forces exerted to the motor housing (7) due to the reactive torque action of the rotating drill bit (9) in the borehole.

3. The method of claim 1 or 2, wherein said control means (23) includes one of the group of a hydraulic motor and an electric motor.

4. The method of any of claims 1-3, said drill string forming a coiled tubing (5) which is reeled onto a reel, wherein the coiled tubing is unreeled from the reel and lowered into the borehole as drilling of the borehole proceeds.

5. A drilling assembly for creating a borehole in an earth formation, comprising a drill string extending into the borehole, a downhole motor (6) including a housing (7) and a drive shaft (8) for rotating a drill bit (9), which drive shaft is oriented inclined relative to a longitudinal axis of the lower part of the drill string, the motor housing (7) being connected to the lower part of the drill string in a manner so as to allow rotation of the motor housing (7) about said longitudinal axis, the drilling assembly further comprising control means (23) to control rotation of the motor housing (7) about said longitudinal axis and relative to the drill string, means for drilling a substantially straight section of said borehole by inducing said control means (23) to rotate the motor housing (7) continuously about said longitudinal axis and relative to the drill string while the downhole motor (6) is operated to rotate the drill bit (9), and means for alternating the step of drilling said sub-

stantially straight borehole section with a step of drilling a curved section of said borehole by inducing said control means to prevent rotation of the motor housing (7) about said longitudinal axis and relative to the drill string while the downhole motor (6) is operated to rotate the drill bit (9), characterized in that means are provided for, prior to drilling the curved section, inducing said control means to rotate the motor housing (7) about an angle corresponding to a selected orientation of the drill bit (9) relative to the borehole.

6. The drilling assembly of claim 5, wherein said control means (23) does not include means for controlling rotation of the motor housing (7) about said longitudinal axis and relative to the drill string, which rotation is caused by reactive torque forces exerted to the motor housing (7) due to the reactive torque action of the rotating drill bit (9) in the borehole.

7. The drilling assembly of claim 5 or 6, wherein said control means (23) includes one of the group of a hydraulic motor and an electric motor.

8. The drilling assembly of any of claims 5-7, wherein said drill string forms a coiled tubing (5) which is reeled onto a reel, the assembly further comprising means for unreeling the coiled tubing from the reel and lowering the coiled tubing (5) into the borehole as drilling of the borehole proceeds.

Patentansprüche

1. Verfahren zum Herstellen eines Bohrloches in einer Erdformation mit Hilfe einer Bohranordnung mit einem Bohrstrang (5), der in sich in ein Bohrloch hineinerstreckt, einem unten im Bohrloch arbeitenden Motor (6) mit einem Gehäuse (7) und einer Antriebswelle (8) zum Drehen einer Bohrkrone (9), welche Antriebswelle eine geneigte Orientierung relativ zu einer Längsachse des unteren Teiles des Bohrstranges besitzt, wobei das Motorgehäuse mit dem unteren Teil des Bohrstranges in einer solchen Weise verbunden ist, daß eine Drehung des Motorgehäuses (7) um die genannte Längsachse möglich ist, wobei die Bohranordnung ferner Steuerungsmittel (23) zum Steuern der Drehung des Motorgehäuses (7) um die genannte Längsachse und relativ zum Bohrstrang umfaßt, wobei das Verfahren das Bohren eines im wesentlichen geraden Abschnittes des Bohrloches umfaßt, indem die Steuerungsmittel (23) dazu veranlaßt werden, das Motorgehäuse (7) kontinuierlich um die genannte Längsachse und relativ zum Bohrstrang zu drehen, während der unten im Bohrloch arbeitende Motor (6) zum Drehen der Bohrkrone (9) betrieben wird, wobei der Schritt des Bohrens des im wesentlichen geraden Bohrlochabschnittes mit einem weiteren Schritt des Bohrens eines gekrümmten Abschnittes des Bohrloches, indem die Steuerungsmittel (23) dazu veranlaßt werden, die Drehung des Motorgehäuses (7) um die genannte Längsachse und relativ zum Bohrstrang zu verhindern, während der unten im Bohrloch arbeitende Motor (6) zum Drehen der Bohrkrone (9) betrieben wird, abgewechselt wird, dadurch gekennzeichnet, daß vor dem Schritt des Bohrens des gekrümmten Abschnittes die Steuerungsmittel (23) dazu veranlaßt werden, das Motorgehäuse (7) um einen Winkel zu drehen, welcher einer ausgewählten Orientierung der Bohrkrone (9) relativ zum Bohrloch entspricht.

2. Verfahren nach Anspruch 1, bei welchem die Steuerungsmittel (23) keine Mittel zum Steuern der Drehung des Motorgehäuses (7) um die genannte Längsachse und relativ zum Bohrstrang enthalten, welche Drehung durch die Reaktionsdrehmomentkräfte hervorgerufen wird, die durch die Reaktionsdrehmomentwirkung der im Bohrloch drehenden Bohrkrone (9) auf das Motorgehäuse (7) ausgeübt werden.

3. Verfahren nach Anspruch 1 oder 2, bei welchem die Steuerungsmittel (23) ein Element aus der Gruppe bestehend aus Hydraulikmotor und Elektromotor enthalten.

4. Verfahren nach einem der Ansprüche 1 bis 3, wobei der Bohrstrang einen Wickelrohrstrang (5) bildet, der auf eine Spule aufgewickelt ist, wobei der Wikkelrohrstrang während des Bohrlochfortschrittes von der Spule abgewickelt und in das Bohrloch abgesenkt wird.

5. Bohranordnung zum Herstellen eines Bohrloches in einer Erdformation, mit einem Bohrstrang, der sich in das Bohrloch hineinerstreckt, einem unten im Bohrloch arbeitenden Motor (6) mit einem Gehäuse (7) und einer Antriebswelle (8) zum Drehen einer Bohrkrone (9), welche Antriebswelle bezüglich einer Längsachse des unteren Teiles des Bohrstranges geneigt orientiert ist, wobei das Motorgehäuse (7) mit dem unteren Teil des Bohrstranges in einer Weise verbunden ist, die eine Drehung des Motorgehäuses (7) um die genannte Längsachse ermöglicht, wobei die Bohranordnung ferner Steuerungsmittel (23) zum Steuern der Drehung des Motorgehäuses (7) um die genannte Längsachse und relativ zum Bohrstrang umfaßt, Mittel zum Bohren eines im wesentlichen geraden Abschnittes des Bohrloches durch Veranlassen der Steuerungsmittel (23) zu einer Drehung des Motorgehäuses (7) kontinuierlich um die genannte Längsachse und relativ zum Bohrstrang, während der unten im Bohrloch arbeitende Motor (6) zum Drehen der Bohrkro-

ne (9) betrieben wird, und Mittel zum Abwechseln des Schrittes des Bohrens des im wesentlichen geraden Bohrlochabschnittes mit einem Schritt des Bohrens eines gekrümmten Abschnittes des Bohrloches, indem die Steuerungsmittel dazu veranlaßt werden, die Drehung des Motorgehäuses (7) um die genannte Längsachse und relativ zum Bohrstrang zu verhindern, während der unten im Bohrloch arbeitende Motor (6) zum Drehen der Bohrkrone (9) betrieben wird, dadurch gekennzeichnet, daß Mittel vorgesehen sind, um die Steuerungsmittel, bevor der gekrümmte Abschnitt gebohrt wird, dazu zu veranlassen, daß das Motorgehäuse (7) um einen Winkel gedreht wird, welcher einer ausgewählten Orientierung der Bohrkrone (9) relativ zum Bohrloch entspricht.

6. Bohranordnung nach Anspruch 5, bei welcher die Steuerungsmittel (23) keine Mittel zum Steuern der Drehung des Motorgehäuses (7) um die genannte Längsachse und relativ zum Bohrstrang enthalten, welche Drehung durch die Reaktionsdrehmomentkräfte verursacht wird, die auf das Motorgehäuse (7) auf Grund der Reaktionsdrehmomentwirkung der im Bohrloch rotierenden Bohrkrone (9) auf das Motorgehäuse (7) ausgeübt werden.

7. Bohranordnung nach Anspruch 5 oder 6, bei welcher die Steuerungsmittel (23) ein Element aus der Gruppe bestehend aus Hydraulikmotor und Elektromotor enthalten.

8. Bohranordnung nach einem der Ansprüche 5-7, bei welcher der Bohrstrang einen Wickelrohrstrang (5) bildet, der auf eine Spule aufgewickelt ist, wobei die Anordnung ferner Mittel zum Abwickeln des Wickelrohrstranges von der Spule und zum Absenken des Wickelrohrstranges (5) in das Bohrloch aufweist, während das Bohren des Bohrloches voranschreitet.

Revendications

1. Procédé pour réaliser un sondage dans une formation terrestre utilisant un assemblage de forage comprenant une garniture de forage (5) s'étendant dans le sondage, un moteur de fond (6) comprenant un carter (7) et un arbre de commande (8) pour entraîner en rotation un outil de forage (9), lequel arbre de commande a une orientation inclinée par rapport à un axe longitudinal de la partie inférieure de la garniture de forage, le carter de moteur étant relié à la partie inférieure de la garniture de forage de manière à permettre la rotation du carter de moteur (7) autour dudit axe longitudinal, l'assemblage de forage comprenant de plus un moyen de commande (23) pour commander la rotation du carter de moteur (7) autour de l'axe longitudinal susdit et par rapport à la garniture de forage, ledit procédé comprenant le forage d'une section sensiblement rectiligne du sondage précité en amenant le moyen de commande (23) à faire tourner le carter de moteur (7) de façon continue autour de l'axe longitudinal précité et par rapport à la garniture de forage pendant que le moteur de fond (6) fonctionne pour faire tourner l'outil de forage (9), dans lequel l'étape de forage de ladite section de sondage sensiblement rectiligne est alternée avec une autre étape de forage d'une section infléchie du sondage précité en amenant le moyen de commande (23) susdit à empêcher la rotation du carter de moteur (7) autour de l'axe longitudinal et par rapport à la garniture de forage pendant que le moteur de fond (6) fonctionne en entraînant l'outil de forage (9), caractérisé en ce qu'avant l'étape de forage de la section infléchie, le moyen de commande précité (23) est amené à faire tourner le carter de moteur (7) d'un angle correspondant à une orientation choisie de l'outil de forage (9) par rapport au sondage.

2. Procédé suivant la revendication 1, dans lequel le moyen de commande (23) ne comprend pas de moyen pour commander la rotation du carter de moteur (7) autour de l'axe longitudinal précité et par rapport à la garniture de forage, laquelle rotation est provoquée par des forces de couple réactives exercées sur le carter de moteur (7) dues à l'action de couple réactive de l'outil de forage (9) en rotation dans le sondage.

3. Procédé suivant l'une ou l'autre des revendications 1 et 2, dans lequel le moyen de commande (23) est choisi dans le groupe comprenant un moteur hydraulique et un moteur électrique.

4. Procédé suivant l'une quelconque des revendications 1 à 3, la garniture de forage précitée formant un tube enroulé (5) qui est enroulé sur un touret, dans lequel le tube enroulé est déroulé du touret et descendu dans le sondage au fur et à mesure de la progression du forage du sondage.

5. Assemblage de forage pour réaliser un sondage dans une formation terrestre, comprenant une garniture de forage s'étendant dans le sondage, un moteur de fond (6) comprenant un carter (7) et un arbre de commande (8) pour entraîner en rotation un outil de forage (9), lequel arbre de commande est orienté de façon inclinée par rapport à un axe longitudinal de la partie inférieure de la garniture de forage, le carter de moteur (7) étant relié à la partie inférieure de la garniture de forage de manière à permettre la rotation du carter de moteur (7) autour de l'axe longitudinal, l'assemblage de forage comprenant de plus un moyen de commande (23) pour commander

la rotation du carter de moteur (7) autour de l'axe longitudinal et par rapport à la garniture de forage, un moyen pour forer une section sensiblement rectiligne du sondage en amenant ledit moyen de commande (23) à faire tourner le carter de moteur (7) de façon continue autour dudit axe longitudinal et par rapport à la garniture de forage pendant que le moteur de fond (6) fonctionne en faisant tourner l'outil de forage (9), et un moyen pour alterner l'étape de forage de la section de sondage sensiblement rectiligne avec une étape de forage d'une section infléchie dudit sondage en amenant le moyen de commande susdit à empêcher la rotation du carter de moteur (7) autour de l'axe longitudinal et par rapport à la garniture de forage pendant que le moteur de fond (6) fonctionne en faisant tourner l'outil de forage (9), caractérisé en ce qu'un moyen est prévu, avant le forage de la section infléchie, pour amener le moyen de commande précité à faire tourner le carter de moteur (7) d'un angle correspondant à une orientation choisie de l'outil de forage (9) par rapport au sondage.

6. Assemblage de forage suivant la revendication 5, dans lequel le moyen de commande (23) ne comprend pas de moyen pour commander la rotation du carter de moteur (7) autour de l'axe longitudinal précité et par rapport à la garniture de forage, laquelle rotation est provoquée par des forces de couple réactives exercées sur le carter de moteur (7) dues à l'action de couple réactive de l'outil de forage (9) en rotation dans le sondage.

7. Assemblage de forage suivant l'une ou l'autre des revendications 5 et 6, dans lequel le moyen de commande (23) est choisi dans le groupe comprenant un moteur hydraulique et un moteur électrique.

8. Assemblage de forage suivant l'une quelconque des revendications 5 à 7, dans lequel la garniture de forage précitée forme un tube enroulé (5) qui est enroulé sur un touret, l'assemblage comprenant en outre un moyen pour dérouler le tube enroulé du touret et descendre le tube enroulé (5) dans le sondage au fur et à mesure de la progression du forage du sondage.

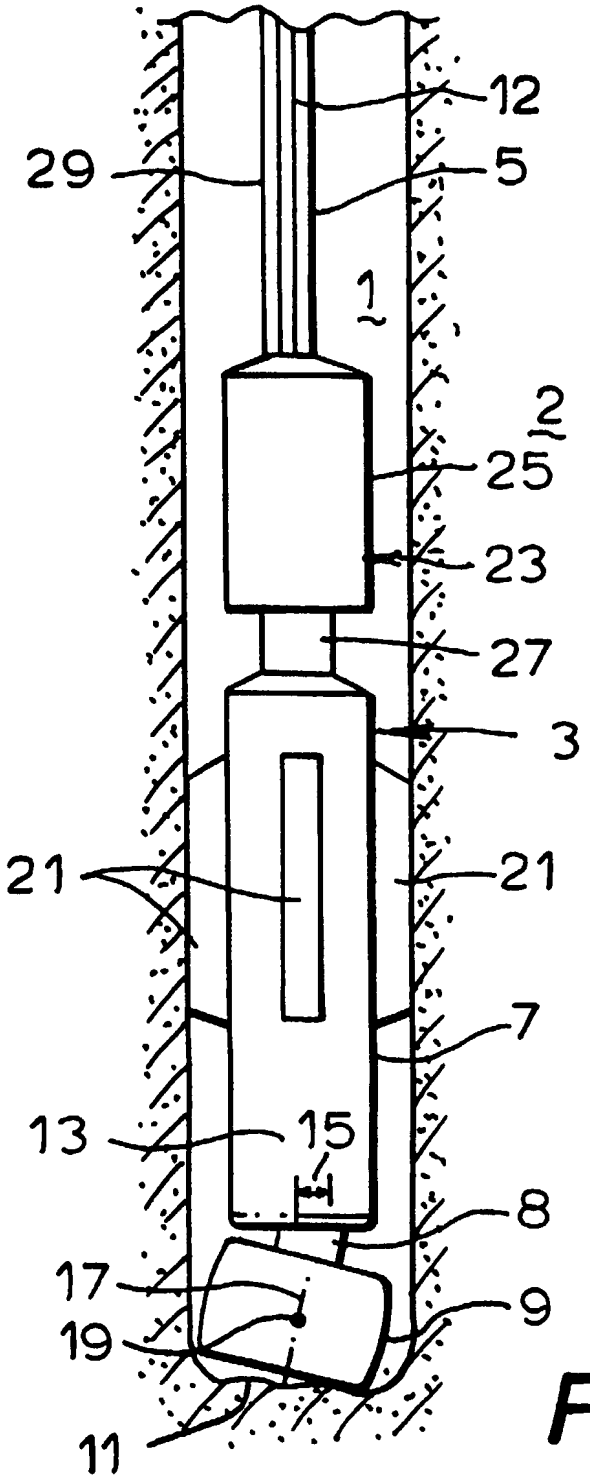

FIG.1